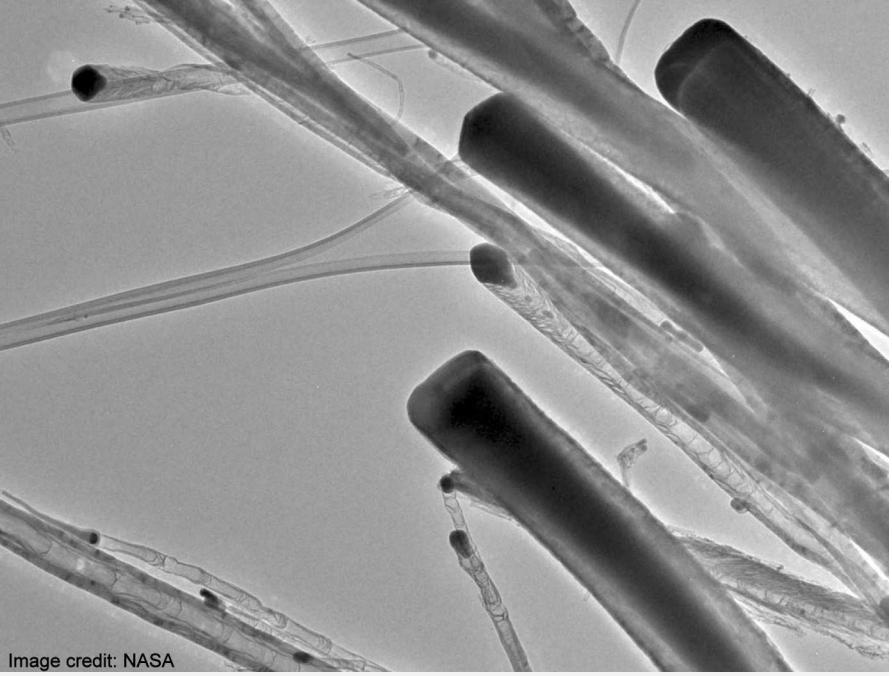


Image credit: NASA

National Aeronautics and Space Administration

Materials and Coatings

Fine-Grained Targets

High-yield synthesis of carbon nanotubes via free electron laser ablation

NASA's Langley Research Center scientists originally developed a Free Electron Laser (FEL) Ablation technique to synthesize single-walled carbon nanotubes. FEL provides a vast improvement over other techniques employed to make carbon nanotubes. The nanotubes produced by FEL are very pure, straight, homogenous, and defect-free. Most notable is that these nanotubes can be produced in much larger quantities than by other laser-based techniques. Now NASA scientists have further provided incremental improvement in this technology by creating a recipe and procedure for the inexpensive and simple production of fine-grained targets required for the synthesis of carbon nanotubes using FEL. Previously used targets employed metal powders that did not have a particularly small grain size or small size dispersibility. The targets used here are made of powder forge metals that are both small and dispersible. The targets facilitate a significant cost reduction in the supply of high-quality single-walled carbon nanotubes.

BENEFITS

- Uses inexpensive material to make carbon nanotubes
- Facilitates high-yield nanotube production
- Very small and dispersible targets enable more complete catalysis
- Targets are significantly less expensive than those currently used
- Targets produce high quality and research grade carbon nanotubes
- Nanotubes are straight, homogenous, and defect-free

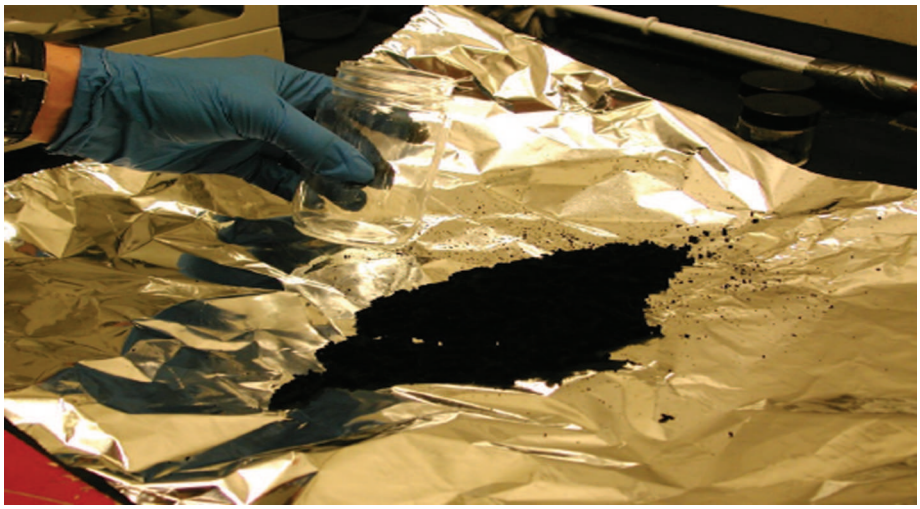
APPLICATIONS

- These targets will facilitate the production of high quality single-walled carbon nanotubes in large quantities synthesized via the FEL technique. Carbon nanotubes of this nature and size have been difficult to make in high yield, limiting their commercial viability. This advancement opens the door to potential industry applications that have so far not been conceived. An initial application would be in fiber-reinforced composites used in aerospace.

technology solution

THE TECHNOLOGY

The fine-grained targets are a matrix of a prismatic edge natural flake graphite that produces strong structural pi bonds when pressed at room temperature. The targets have an approximate grain size of 2 microns. The graphite provides a carbon source that is combined with a metal catalyst made of powder forge nickel and powder forge cobalt. Previously used targets involved pressing and binding targets with Dylon carbon cement. These particles had an approximate 200-micron particle size, which led to large regions of uncatalyzed target. The new metal powders are small (~0.5 microns), highly dispersible, and two orders of magnitude less expensive. The powders are mixed in appropriate quantities and subjected to low-energy ball-milling to ensure mingling. Targets undergo additional preparatory steps, including high pressure processing. The targets are then subjected to a series of ultrafast infrared laser light pulses at a high repetition rate to vaporize the layers of the spinning targets and create a plume of nanotubes.



Example of the yield of the carbon nanotubes. Image credit: NASA

Example of a new and expended fine-grained target. Image credit: NASA

PUBLICATIONS

Patent No: 9,133,032

Patent Pending

More Information

National Aeronautics and Space Administration

The Technology Gateway

Langley Research Center

Mail Stop 151
Hampton, VA 23681
757.864.1178
LARC-DL-technologygateway@mail.nasa.gov

http://technology.nasa.gov/

www.nasa.gov

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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